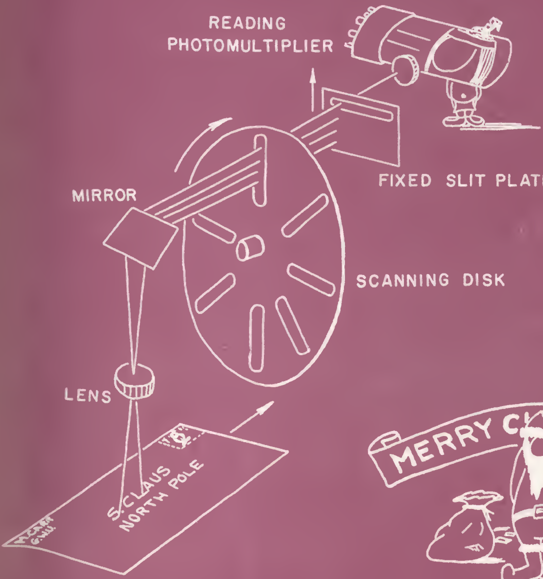
Mechelectiv

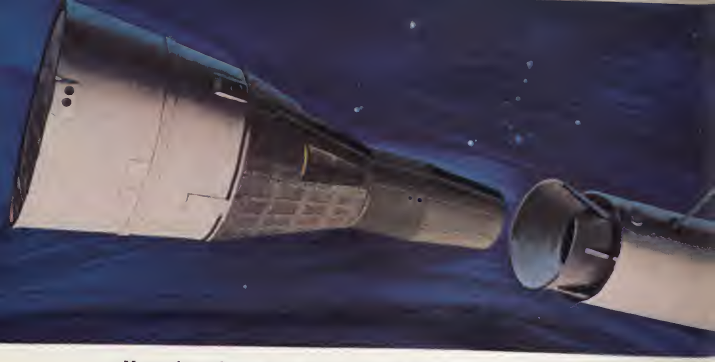
Volume 23 December - 1964 No. 3

AUTOMATIC MAIL SORTER



THE GEORGE WASHINGTON UNIVERSITY

DECEMBER 1964



Moon shot rehearsal: when the Gemini spacecraft meets its target

Westinghouse radar will guide the astronauts to this meeting in outer space

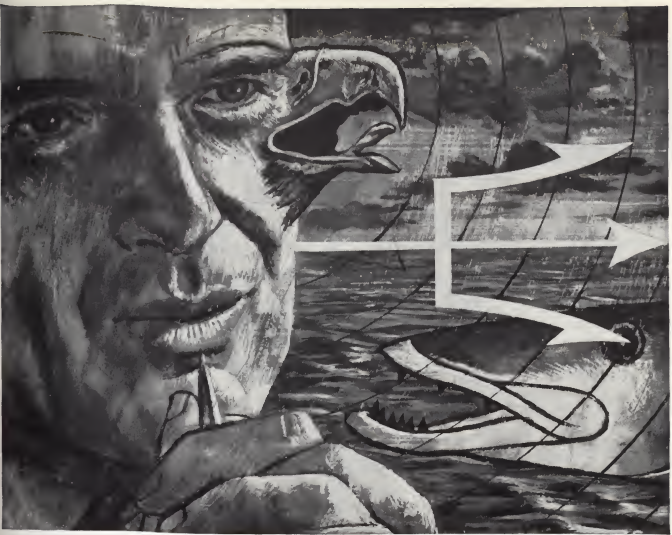
When the Gemini two-man spacecraft lifts off, a dramatic dress rehearsal for the first moon trip will begin. The astronauts' mission: to maneuver their spacecraft and join it with an Agena rocket already orbiting the earth at more than 17,500 miles per hour.

A new Westinghouse radar system will guide the chase. Locating the target, the spacecraft will send out radar pulses. Computer-translated responses will guide the astronauts until the target is reached.

A vital prelude to future space travel, the rendezvous experiment will one day be routine. Meanwhile, Westinghouse is already working on other advanced radar systems for lunar landings, planet exploration, space station support and deep space missions.

You can be sure if it's Westinghouse

For information on a career at Westinghouse, an equal opportunity employer, write L. H. Noggle, Westinghouse Educational Department, Pittsburgh, Pa. 15221.



The Mecheleciv

VOLUME 23 DECEMBER - 1964 No. 3

ARTICLES page

Reliability, Maintainability, and Availability
K. Vairavan 7

Automatic Sorting of Mail
Norman Seidle 8

The Turbo-Encabulator
Col. Joseph Gurrepin 10

The Open Forum on "Teaching Methods"
George Miller 11

The Wankel-Curtiss-Wright Rotating Combustion Engine
Joseph Brinkmoeller 14

A Resonant Frequency Bathroom
Guerdon Trueblood 18

Poll of Faculty Concerning Open Forums
University Committee, Sigma Tau 22

DEPARTMENTS

Editorial 4
Letter to the Editor 4
Faculty Spotlight 12
Campus News 16
Mech Miss 17
What's New 21
The Shaft 28

Published at the George Washington University by direction of the Engineers' Council. Published six times during the school year in October, November, December, March, April, and May. Second class postage paid at Washington, D. C. Address communications to Mecheleciv Magazine, Davis-Hodgkins House, George Washington University, Washington 6, D. C., or telephone 333-0173.

Subscription Price: Two Dollars

CHANGE OF ADDRESS: Send your new address at least 30 days before the date of the issue with which it is to take effect.

THE IMPORTANCE OF FEEDBACK IN THE TEACHING PROFESSION

As a student for almost six years now, I have been observing Professors and instructors as they teach. On the basis of this experience, I would like to point out an error which I feel is made by many teachers and students alike — the failure to realize that a lecture, to be effective, must be a two-way process uniting the teacher and the student, not a one-sided performance by the teacher. In other words, good teaching cannot take place, except perhaps by chance, without some form of feedback.

Feedback, as you know, is a reverse flow of information that is used to control some process. This concept is well applied to the teaching process. Now it is true that teaching can take place without feedback, but only with great risks. The instructor knows that he has given a lecture, but unless there is some form of response from his students, he does not know if any learning actually took place as a result of the lecture. Herein lies one of the basic distinctions between good teaching and bad teaching. A good teacher measures the immediate effectiveness of his lecture by student response and adjusts his lecture accordingly. In contrast to this, the poor teacher seems to ignore the blank or bored faces of his students, or if he does notice, he does nothing to alter the situation. Therefore, it is the responsibility of the teacher to determine the effectiveness of his lectures and improve them if necessary.

On the other hand, since effective teaching is a two-way process, the student must have his share of the responsibility. We all realize that no teacher can make a student learn; only the student himself can do that. But how much responsibility does the student have in this area of feedback? In examinations, of course, feedback is mandatory. However, examinations occur only infrequently, so students should be willing to offer some form of feedback to the instructor during ordinary class periods.

What forms should this voluntary feedback take? Should a student walk up to his professor after class and tell him that the lecture lacked organization and clarity? It is rare for a "grade conscious" student to have the nerve to do something like that, and it does show a certain amount of disrespect even if the criticism is just. If direct criticism cannot be used, then I would say that the best form of feedback is asking questions. Since from the nature of the questions asked in class, the teacher can easily judge the effectiveness of his lecture. So as students we should realize that by asking questions, we are doing not only ourselves but also the rest of the class a favor for we are showing the teacher where his lecture can be improved. Also we should not underestimate the importance of facial expressions as a form of feedback. Most teachers can tell how well they are doing by the expressions on their students' faces. So if a student is bored, why shouldn't he look bored; if he is confused, why shouldn't he look confused and let the teacher know that he is. In addition to these there are probably other forms of classroom feedback that the alert student can come up with.

We must remember, however, that final responsibility for accepting and making good use of feedback belongs to the teacher. But the student can remember the importance of feedback and he can and should take part in this feedback process. And for forty dollars a credit hour, I should think most students would want to do their share in improving the effectiveness of the teaching process. —J.L.E.

LETTER TO THE EDITOR

Dear Editor:

May we congratulate you for choosing a very beautiful creature for your "Mech Miss" in the October, 1964 issue of Mecheleciv. However, it exceeds the elastic limit of our imagination to correlate the measurements of Miss Tompkins with her pictures.

According to the apparently well-known conversion factor of one kilogram equals 2.2046 pounds, and our trusty, well greased Post Versalog slide rules, we obtain a weight of 557 pounds for Miss Tompkins. Also, we rather doubt the bust measurement of 33-1/2 inches, especially if it is to correspond with this weight.

If she can hide all that weight that well, please send us her address so that we can learn her secret. It will no doubt be worth many millions of dollars to people suffering from the perils of obesity.

Sincerely yours,

Robert L. Baldwin, Editor
Gerald W. Hieronymus, Graduate Advisor
The Kentucky Engineer
University of Kentucky

See the Fair in '65

Unisphere® presented by USS United States Steel
© 1961 New York World's Fair 1964-1965 Corporation

What's your career sphere at Sikorsky Aircraft?

There's a thrilling new perspective of the World's Fair, when viewed from the vantage point of this Sikorsky S-61N These aerial tours demonstrate vividly the adaptability of Sikorsky VTOL aircraft to wide-ranging transportation needs.

But let's take the larger view of Sikorsky in action—and what it can mean to you in terms of a rewarding career.

Sikorsky Aircraft is the pioneer and leading producer of VTOL aircraft. We believe that our exciting programs—aimed far ahead into the future—can provide an ideal environment for young engineers who want to grow with a dynamic industry.

The Sikorsky vehicle of today is an *advanced* VTOL system . . . merging the technologies of electronics and the airframe to provide the world's most versatile means of transportation. And our *continuing objective* is the further advancement of this sophisticated *new technology.*

And what about you? As a Sikorsky engineer, you would be helping to move "tomorrow" closer by working in small interdependent groups on demanding problems in such areas as **aerodynamics • human factors engineering • automatic controls • structures engineering • weight prediction • systems analysis • operations research • reliability/maintainability engineering • autonavigation systems • computer technology** . . . among others.

Opportunities for individual stature and personal progress are here . . . *now.*

And professional competence is further advanced by our corporation-financed Graduate Education Program.

Please consult your College Placement Office for campus interview dates—or—for further information, write to Mr. Leo J. Shalvoy, Engineering Personnel.

Sikorsky Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION

STRATFORD, CONNECTICUT

An Equal Opportunity Employer

RELIABILITY, MAINTAINABILITY AND AVAILABILITY

by K. Vairavan

Engineers on designing their systems or equipment are concerned about the capability of the systems or equipment to function without failures, or in other words they are concerned about the reliability of the system they have designed. Reliability is assuming great importance in this modern day of science in which highly complex devices are used for military and scientific purposes. The RETMA (Radio Electronics and Television Manufacturers Association) definition of reliability is as follows: "Reliability is the probability of a device performing its purpose adequately for the time intended under the operating conditions encountered." The underlined terms are important and they have to be specified before reliability is evaluated. Before we derive the mathematical expression, we shall consider the types of failures.

Failures

Failures may be classified as follows:

(a) Early Failures: These generally result from poor design or poor manufacturing and quality control techniques during the production process.

(b) Wearout Failures: These are caused by wearout of parts and they generally occur only when the equipment is not properly maintained.

(c) Chance Failures: These are random failures and the causes are not easily determined, although a sudden accumulation of stress is the cause in many cases.

It is apparent from the characteristics of the above failures that the first two can be avoided by proper design, manufacturing techniques, and maintenance action.

The Exponential Law:

It can be shown that the probability function associated with the failures of equipments (assuming they are random and independent) is best approximated by the poissan's distribution:

$$P_n = \frac{\lambda^n e^{-\lambda}}{n!}$$

where P_n the probability of n failures, λ = expected number of failures = rt, where r = failure rate in failures per hour, and t = total time in hours. Hence the probability that no failure occurs in time t, or the reliability at time t, is

$$P_o = R = \frac{\lambda^o e^{-rt}}{o!} = e^{-rt}$$

This is a famous exponential law which is widely accepted. This tells us that if we know r, we can predict the reliability of an equipment at anytime t, provided r remains constant with time. Tests in the field have shown that if the design is mature, r will be essentially a constant throughout the operating period of the equipment. The failure rate, r, can also be expressed as the reciprocal of 'the mean time to failures' m. Thus,

$$\text{Reliability} = e^{rt} = e^{t/m}$$

Improving Reliability:

Some of the methods adopted to enhance the reliability of equipments are:

(1) Ensuring high reliability of components or parts. This is achieved by proper manufacturing techniques.

(2) Securing detailed reports of failures from the field and using the data to modify the design of the equipments. This could result in considerable improvement of reliability if the 'feedback' is effectively done.

(3) Proper operation and maintenance of the system. Maintenance actions should be carried out as specified and worn out parts replaced. Improper use of the equipment could considerably affect its reliability.

(4) Providing redundant or extra parts. Redundancy could be effectively used to increase reliability. Redundancy is just a design technique by which redundant parts are provided so that in case of failure of the main component, the unit still functions. There are three types of redundancies:

> (1) Simple standby redundancy: The redundant part functions only when the main part has failed.
>
> (2) Simple active redundancy: The redundant part functions even during the normal operation of the unit.
>
> (3) Redundancy using majority organ: This type of redundancy is primarily used in digital circuits. A digital circuit performing certain logic functions has an even number of copies of itself. There is a majority organ or a vote taker whose output is the same as the majority of the outputs of redundant units.

The disadvantages of redundancy techniques are increased weight and complexity of the equipment.

Maintainability:

The Defense Department defines maintainability as "a quality of the combined features and characteristics of equipment design which permits or enhances the accomplishment of maintenance by personnel of ordinary skill under natural and environmental conditions under which it will operate." This definition just gives the concepts and is not useful in design. A more useful definition (taken from "Reliability Principles and Practices," Calabro) would be that "Maintainability is the probability that the

(Continued on page 25)

K. Vairavan graduated from the Madras University, Madras, India, in 1962. He worked as a Junior Engineer at the Madras State Electricity Board for a year before coming to the United States to do graduate work in electrical engineering. His primary interest is in computers.

AUTOMATIC SORTING OF MAIL

When a machine that will automatically read and sort the mail in a post office is mentioned, the first reaction is usually "impossible". The truth is that if a machine can be made to read and sort all non-handwritten addresses, it will read and sort approximately 98 out of every 100 letters fed into the machine. There are good reasons for this. In the major business areas where millions of letters are handled daily, most of the mail consists of bills, advertisements, business correspondence, etc. All of this mail is typewritten, addressographed, or otherwise not handwritten. This non-handwritten mail accounts for about 98 per cent of the total mail. Therefore, since most of the mail is business mail which is nearly always typewritten, it is not necessary to read handwriting.

However, because handwritten mail may be rejected does not mean the machine will be easy to design. There are still "Z"s that look like "2"s and "T"s that look like "I"s. Also, broken, dirty, or worn type yields broken and smudged characters. "e"s and "a"s and "o"s are frequently just a blob of ink. Account numbers and advertising are frequently mixed in with the address block. Mail order houses may use colored envelopes resulting in poor contrast. The point is that if a machine is to be of benefit, it must be able to read nearly all of the mail.

BASIC PRINCIPLES OF OPTICAL CHARACTER RECOGNITION

Optical character recognition techniques employ some of the principles of narrow beam scanning used in television. That is to say, as shown in figure 1, a character is scanned from bottom to top (vertically rather than horizontally) by a

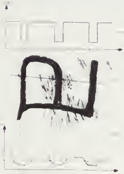
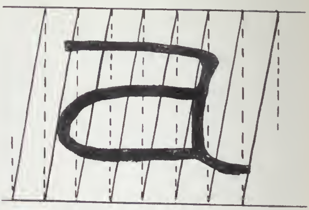


Figure 1. Scanning the Character "a".

narrow beam of light sweeping in a sawtooth fashion. If a photoelectric device like those found in TV cameras is employed, an electrical voltage proportional to the amount of reflected light will be developed. Thus, for example, there will be a marked change in the voltage level every time one of the horizontal lines in the character "a" is crossed. This is illustrated in figure 2a by showing the time dependent voltage corresponding to one of the scans in the center of figure 1.

But what happens if the "a" is not clean and sharp; suppose it is just a blob of ink? Here is where a departure from TV principles is made. First, it is assumed that the lines where the "a"



a. When the letter is printed clean and sharp.
b. a also showing smudging and blobing.
c. Typical sides from a smudged or ink blob type a.

Figure 2. Electrical Signal When Scanning through Center of a.

should be located are darker than the rest of the blob. For example, examine figure 2b. The electrical signal will contain all levels of signal at its output, and may indeed look similar to that shown in figure 2c. But if an electronic circuit is made which says, "if the video is below level AA, an actual part of the character is being scanned and therefore make the output correspond to the "dark level"; but if the level is above line AA, smudges, etc. are being scanned and therefore make the output correspond to the "light" or "no video level", then a pattern similar to that of a clean character is forced out of this smudge or blob of ink. This process is known as quantizing. The result is that after an entire character has been scanned there exists a series of pulses which is characteristic of the character being scanned and independent of smudging.

A particular character, either clean or smudged, may then be recognized by this characteristic set of pulses. But, however, if several characters have nearly the same set of characteristic pulses, it will be difficult if not impossible to reliably distinguish one character from the other.

FUNDAMENTAL BLOCK DIAGRAM

The technology associated with the reliable sorting of mail is a closely guarded secret in this highly competitive field, but, however, the fundamental principles may be explored.

As indicated by the general literature, upper case letters may be identified as such, but it is presently impossible to identify lower case characters. This is due to many reasons, but mostly because lower case characters contain a wider variety of sizes and styles; considerable broken, dirty, and misplaced type; and the vowels have very similar characteristic pulse trains. Consequently, each machine is essentially two completely separate machines; one machine is used if the address is written in upper case, a second machine is used if the address is written in lower case. As depicted in figure 3, the correct machine

by Norman Seidle

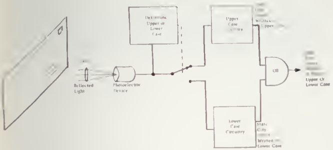


Figure 3. Rudimentary Address Reading Machine.

is connected by an electronic circuit which decides whether the address is written in upper or lower case. Therefore, each machine or method will be considered separately.

UPPER CASE. It was previously mentioned that each upper case letter may be identified per se by its characteristic pulse train. Therefore, to read a word in upper case one would simply determine each letter and its position in the word. However, two problems arise. Some characters such as "O" and "Q" are very difficult if not impossible to reliably distinguish from each other. Also, there is the practical problem that the logic circuitry involved in determining each of the 26 letters is excessive. Thus this basic method of reading a word by identifying the 26 upper case characters must be refined.

To reduce the excessive circuitry, the fact that the characteristic pulse trains of the 26 letters contain many striking similarities may be used. For example, the vertical and crossed top in "I" and "T" are the same. "C" and "O" and "D" and "G" and "Q" consist of rounded portions. An analysis of these similarities will yield about 30 to 40 different characteristics which may be combined to produce the characteristic features of any of the 26 letters. A few of these characteristics are:

Square Left	Two Thirds Vertical
Negative Sloping Edge	Open Right
Black Upper Right	Square or serified Left
Long Vertical not on Left Edge	White Left Center
Notch Bottom	Left Overhang

For example, to recognize the letter "B", the character must contain (1) Square Left, and (2) three crossings, <u>and</u> it must not contain (1) Black Upper Right, (2) Notch Bottom, or (3) White Left Center. Of course there are other characteristics applicable to "B", but they may not be necessary to distinguish "B" from the remaining 25 letters. Thus by designing logic circuitry to make 30 to 40 statements, and combining them in proper groups, it is possible to recognize each of the 26 letters. And by using these characteristics rather than the characteristic pulse train, the quantity of logic circuitry is greatly reduced.

Having solved the problem of excessive circuitry, it is now worthwhile to investigate the problem of characters with similar characteristics.

Norman Seidle, B.S. (Electronics), works for Farrington Electronics, Inc., where he is helping in the development of the postal sorting system described in this article. In addition to carrying a heavy load as a part-time student, Norman is active in THETA TAU fraternity, and President of SIGMA TAU fraternity.

The solution to this problem may seem obvious, but it is the result of a tremendous research effort and must be used with extreme care. Usually, but not always, upper case characters with similar characteristics do not have to be distinguished from each other. For example, it is very rare indeed to find the one and only difference in an entire word to be the difference between "O" and "Q". Therefore, why bother to distinguish "O" from "Q"? The letters within certain groupings of upper case characters will rarely need to be distinguished from each other.

Thus if the 26 letters of the alphabet are grouped according to both the need to distinguish letters from each other and the ease of separating letters from each other, the result will be the eight groups of letters listed in Table I. Therefore, as an example of the use of these groups

TABLE I

Groups of Upper Case Characters

Number	Letters in Group
I	A
II	FP
III	JL
IV	KRX
V	BESZ
VI	ITVY
VII	CDGOQ
VIII	HMNUW

suppose it is necessary to distinguish PENN from TENN. The only difference is that the first character is "P" or "T"; but instead of saying the first character is "P" or "T", the machine will say, "the first character has the characteristics of either "P" or "F", or the first character has the characteristics of either "I", "T", "V", or "Y"," to distinguish PENN from TENN. Thus the use of groupings of upper case characters reduces the problem of characters with similar characteristics.

There are, of course, several cases when this grouping is not valid and consequently the individual letters must be used. A few examples for RI and KY, NM and NH, NC and ND, MD and MO, CAR and DAK, etc. In cases like these, the mis-read rate is very high and this fact must be accepted. But since human postal clerks have a mis-sort rate on the order of 2%, if the reading machine has a similar overall mis-sort on the order of 2%, then these errors in reading can be tolerated.

Now to summarize the functional chain of events which occur when a word is written in upper case. First, the fact that the print is upper case is sensed and the upper case circuitry is switched into the system. As the word passes the photoelectric device, each character is scanned. While a letter is being scanned, its characteristics are determined and stored. As soon as the

(Continued on page 25)

THE TURBO-ENCABULATOR

Contributed by Col. Joseph Gurrepin

Col. Joseph I. Gurrepin graduated from the U. S. Military Academy, West Point. He received his Masters from Harvard and is now working for a doctorate in Applied Mechanics here at the George Washington University School of Engineering. Col. Gurrepin has been assigned by the Army to France, Japan, Korea and many other countries. He holds the distinct honor of being the only grand-father working toward an engineering doctorate at G.W.

For a number of years now work has been proceeding on a machine that would not only supply inverse reactive current for use in unilateral phase detractors, but would also be capable of automatically synchronizing cardinal grammeters. Such is the "Turbo-Encabulator." Basically, the only new principle involved is that instead of power generated by the relative motion of conductors and fluxes, it is produced by the modial interaction of magnetroreluctance and capacitive directance.

The original machine had a base-plate of prefabulated amulite, surmounted by a malleable logarithmic casing in such a way that the two spurving bearings were in a direct line with the pentametric fan. The latter consisted simply of six hydrocoptic marzelvanes, so fitted to the ambifacient lunar waneshaft that side fumbling was effectively prevented. The main winding was of the normal lotus-o-delta type placed in panendemic semi-boloid slots in the startor, every seventh conductor being connected by a non-reversible tremiepipe to the differential girdlespring on the "up" end of the grammeters.

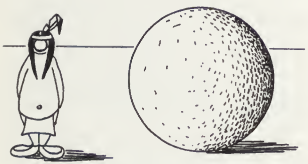
Forty-one manastically spaced grouting brushes were arranged to feed into the roto slipstream a mixture of high S-value phenylhydrobenzamine and five per cent reminative tetryliodohexamine. Both of these liquids have specific pericosities given by P-2.5C, 7.7 where n is the diathetical evolute of retrograde temperature phase disposition and C is cholmondely's annual grillage coefficient. Initially, n was measured with the aid of a matapolar refractive pilfrometer (for a description of this ingenious instrument, see I. E. Rupelverstein in "Zeitschrift fur Elektrotechnistatischs-Donerblitze" Vol. VII), but nothing has been found to equal the transcendental hopper dadoscope. (See "Precedings of the Peruvian Academy of Skatological Sciences" June, 1954).

Electrical engineers will appreciate the difficulty of nubing together a regurgitative purwell and a supramitive wennel-sproket. Indeed, this proved to be a stumbling block to further development until, in 1952, it was found that the use of anhydrous nangling pins enabled a kryptonastic boiling shim to be tankered thereto.

The early attempts to construct a sufficiently robust spiral decommutator failed largely because of a lack of appreciation of the large quasipiestic stresses in the gremlin studs; the latter were specially designed to hold the roffits bars to the spamshaft. When, however, it was discovered that wending could be prevented by a simple addition to the tiving sockets, almost perfect running was secured.

The operating point is maintained as near as possible to the h. f. rem peak by constantly fromaging the bitumogenous spandrels. This is a distinct advance on the standard nivelsheaves in that no dramcock oil is required after the phase de-tractors have remissed.

Undoubtedly, the turbo-encabulator has now reached a very high level of technical development. It has been successfully used for operating nofertrunnions. In addition, whenever a barescent skor motion is required, it may be employed in conjunction with a drawn reciprocating single arm to reduce simusoidal deplenerat ion.



OPEN FORUM HEARS TEACHING METHOD DISCUSSION

by George E. Miller

Norman Seidle, President Sigma Tau, moderated a panel discussion during the third Open Forum before a record audience of seventy-two students and Faculty. After his brief outline of the panel discussion ground rules, he introduced the three panelists: Prof. Louis de Pian, a specialist in Network Theory; Prof. Edward H. Braun, a specialist in Field Theory; and Prof. D. K. Anand, a specialist in Heat Transfer and Thermodynamics. All three professors teach in the School of Engineering and Applied Science and by experience and inclination were well qualified to discuss the evening's topic, "teaching methods".

Upon completion of the introductions, each professor made an approximate eight minute statement presenting his method of teaching. Those brief talks clearly illustrated the wide variance that exists between teaching methods and provided stimulus to the subsequent panel cross-discussion that followed.

Speaking first at the Forum, Prof. de Pian outlined a teaching method which is oriented toward class participation. This mode of teaching obviously requires a large amount of finesse on the instructor's part since he must have the inherent ability to deliver impromptu lectures designed to draw his audience to him and thereby encourage their enthusiasm in problem discussion. The theme of this method may then well be to develop the student's reasoning ability and to condition him to "learn for learning -- not for grade". In accordance with this philosophy, examinations (whether take-home, oral or two-hour final in class -- the student has his choice), are designed to communicate to the teacher a close approximation of what the student learned from the course. Although this optional method of testing consumes a large amount of the instructor's time, it appears at first glance to be an advantage for the student.

Another advantage to be gained by the student is that of absorbing the material from a well presented lecture. Prof. Braun, speaking second in turn, explained a concept of teaching which, contrary to class participatory techniques, stresses the contention that if the right subject matter is put into a course there is no time left for class discussion. This implies that prior to beginning the semester the teacher must decide the amount of subject material to put in the course by searching out the overlapping areas of subsequent or preceding courses. The start of classes will then find him with a prepared class program of material meaningful and appropriate to the course. He then presents the material in a two-fold manner: (1) to emphasize the fundamentals of the subject, and (2) to illustrate to the students how to use those fundamentals for problem solving. It was obvious to those present that the first of the above mentioned goals is the more important of the two since Prof. Braun impressed on the audience how frequent, rapid reviews of the fundamentals helps to bring the poor student upward to the class level (Prof. Braun has keenly observed that the "good" student doesn't mind an occasional review either), and how review sheets distributed among the students before examinations assist them in pinpointing the gist of the course.

If it appears that the teaching methods of Prof. Braun and Prof. de Pian are diametrically opposed, the teaching method of Prof. Anand tends to blend them together since he conducts a slight majority of his class sessions on the basis of prepared lectures, and allows the remaining time for class discussion (the percentage, however, may vary from class to class). Prof. Anand went on to say that most of today's engineering problems contain certain elements which are not solvable by handbook or classical knowledge; some intuition and general knowledge, furnished by the teacher during a discussion session, are necessary. Furthermore, the problems that can't be done serve to challenge the student to take a more comprehensive approach to problem solving, in contrast to the less thought-provoking approach required for the cut-and-tried problem to which the answer is given "in the back of the book". In summary, Prof. Anand's style opposes the "pat method" of teaching and puts greater emphasis on understanding rather than memorizing.

During the panel cross discussion which followed the three talks, the audience was soon made aware that no decision based on a best teaching method would be unanimously agreed upon. Moreover, questions raised by the audience served only to highlight the attractive features of each of the three diverse philosophies.

It was with thoughtful reflection on that variance of teaching methods that Dean Grisamore delivered his impromptu talk which closed the evening's activities. He justly reminded all present that teachers have been, and still are students; therefore, they are acutely aware of the problems facing students in the classroom. Dean Grisamore went on to say that instructors all have different methods of presenting course material and each rightly tends to use the method best for him. In concluding, the Dean remarked that problems with pat answers are appropriate for fundamental courses, but not for the more advanced levels in education.

As is the case after most Forum adjournments, informal groups gathered in the halls to exchange opinions of the discussion. Like teaching methods, the opinions were varied. However, they emphasized how the laudable performance by the panelists led to a greater appreciation for the technical complexity of teaching techniques and to a deeper understanding of the flexibility and skill demanded of all professors.

FACULTY SPOTLIGHT

DR. ROBERT B. HELLER

Dr. Robert B. Heller became associated with The George Washington University School of Engineering and Applied Science in the fall of 1962 as a Professor of Applied Science. In this capacity he has taught and directed studies in both graduate and undergraduate courses in such subjects as Nuclear Physics, Field and Wave Theory, Network Theory, Industrial Electronics, Game Theory and Physical Electronics. Holding a B.S. in Applied Electronics, a M.S. in Physics, and a Ph.D. in Nuclear Physics from St. Louis University makes him well qualified to teach these courses. Before coming to George Washington Dr. Heller taught at St. Louis University for five years. At the present time Dr. Heller is teaching four courses, serving as advisor to several graduate degree candidates, is the principal investigator in a NASA project, and is serving as a consultant in engineering and physics to the Food and Drug Administration. Last summer he served as Director of a workshop group studying the effects of radiation damage to such devices as solar cells and transistors at The Goddard Space Flight Center.

JEROME MARK RAFFEL

A familiar face in the EE lab is that of Jerome Mark Raffel. In the capacity of an Instructor of engineering, Mr. Raffel spends about nine hours every Thursday teaching lab courses. He teaches Engineering 107 - Electronics Laboratory I, Engineering 101 - Communications Laboratory I, and a special EE lab course in connection with the medical school. He also teaches Applied Science 29 - General Network Theory I. Holding a BS in electronics from Maryland University and a MS in ELECTRONICS from Catholic University gives him the necessary background to teach these courses.

At the present time Mr. Raffel is working for his Ph.D. here at George Washington. As a ham radio operator he is helping the Engineering school to establish a ham radio station.

THE WANKEL -- ROTATING COMBUSTION

by Joseph A. Brinkmoeller

HISTORY OF ROTATING COMBUSTION ENGINES

Early Developments

Engineers were already working on rotary engines soon after the first steam engines were introduced. However, many of the problems, in particular sealing, were more easily overcome in a reciprocating type engine, and for this reason most of the development over the past two centuries has been concentrated on the reciprocating engine. Many models of rotary internal combustion engines have indeed been proposed; until recent years, however, very few working models have been produced.

RC6—LONGITUDINAL AND CROSS SECTIONS

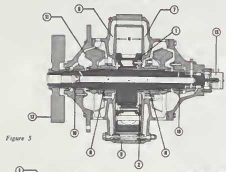


Figure 5

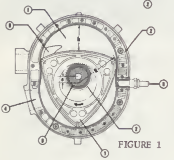


FIGURE 1

1 ROTOR WITH INTERNAL ROTOR GEAR
2. STATIONARY GEAR
3. ROTOR HOUSING
4. EXHAUST PORT
5. SPARK PLUG
6. SIDE HOUSING — DRIVE SIDE
7 SIDE HOUSING — ANTI-DRIVE SIDE
8 INTAKE PORT
9. MAIN BEARING (INNER)
10. MAIN BEARING (OUTER)
11. BALANCE WEIGHT
12. FLYWHEEL
13. IGNITION CONTACT MAKER
a = AXIAL WIDTH OF CHAMBER
R = GENERATING RADIUS
e = ECCENTRICITY
k = R/e
b = MAXIMUM BREADTH OF CHAMBER

Recent Developments

F. E. Heydrich of Prospect, South Australia developed a rotary engine in the 1930's. According to "Australian Mechanical Engineering" the development of the engine is past the prototype stage and ready for final modifications needed for mass production (1)*.

Otto and Erwin Amrein of Switzerland have also developed a vane pump rotary engine; but which, as of 1962, was still in the working prototype stage with no completed tests (2).

Eugen Kauertz, a West German engineer, has developed a two vane four-cycle rotary internal combustion. Kauertz claims 2.25 horsepower per cubic inch and one horsepower for each 4.5 ounces of weight for his engine, which has four power strokes per crankshaft revolution and no unbalanced masses (2).

The engine which is to be discussed here is one originally developed by Felix Wankel.

Felix Wankel

Before World War II, Wankel, a German engineer, began to systematically study rotary engines and analyze their problems. After the war, with the financial assistance of several firms, he reopened his Research Institute where his studies led him to conclude that three main problems had impeded the development of rotary engines. These were:

1) the overwhelming multiplicity of possible arrangements and cycles.

2) the difficult problem of sealing corners in high-pressure chambers.

3) the problem of developing the proper thermodynamic and gas cycle, which included the providing of adequate port areas and the proper timing of stages.

Wankel and his associate, engineer Ernst Hoeppner, designed a small engine which was built and tested at NSU in West Germany under the direction of Dr. Froede. This first engine had a horsepower to displacement (cubic inch) ratio of 1.23 at 17,000 RPM of the rotor.

Curtiss-Wright developed an interest in this engine and concluded a licence and engineering assistance agreement with NSU and Wankel.

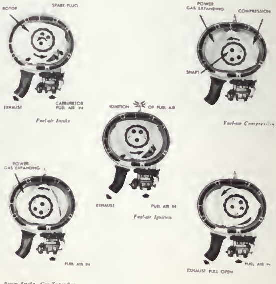


FIGURE 2

*Numbers in parentheses refer to list of references.

CURTISS-WRIGHT ENGINE

Joseph Brinkmoeller is a full-time M.E. student and expects to graduate in June 1965. He is Vice-Chairman of the student section of A.S.M.E. His paper was written last spring for Professor Ojalvo's course in Applied Thermodynamics.

PLOT OF HEAT INPUT PER UNIT OF GAS-EXPOSED AREA   SCHEMATIC OF HOUSING COOLING SYSTEM

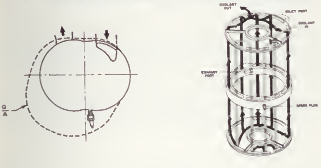


FIGURE 3

Since 1959 Curtiss-Wright, under the direction of Dr. Max Bentele, has built and conducted thousands of hours of tests on various sizes of this engine, ranging in size from 4 cubic inches to 1920 cubic inches.

THE CURTISS-WRIGHT ROTATING COMBUSTION ENGINES

Geometry

The rotor and housing are shown in figure 1. The geometry of the housing walls is that of an epitrochoid, which is a curve traced by a fixed point within a circle of fixed radius which rolls without slipping on the outside of another circle. A precise ratio between the diameters of the two circles must be established to obtain a repetitive and symmetrical epitrochoid. The distance of the point tracing the curve from the center of its circle will determine the amount of cusp in the epitrochoid.

In this engine the pistol of a reciprocating engine is replaced by the three sided rotor, each side of the rotor acting as the piston. The apices of the rotor are in contact with the epitroichoid at all times. Side and apex seals perform functions comparable to piston rings in the reciprocating engine. The combustion chamber is that volume enclosed by the rotor, side housing, and end housing. The mainshaft with its eccentric compare to the reciprocating engine crankshaft. There is little further similarity to the reciprocating internal combustion engine. There are no valves, valve gearings, cams or connecting rods.

Cycle Sequence

The cycle sequence is that of the Otto cycle; however no T-s or p-v diagrams were available for comparison (figure 2). It follows the intake, compression, ignition and combustion, and exhaust sequence of the reciprocating engine. The rotating combustion engine is like the two stroke cycle engine in that it has a power impulse for every revolution of the crankshaft. It differs from either the two- or four-stroke cycle engines in that its power impulse duration is over 270 (90x3) degrees of the crankshaft angle instead of 180 degrees.

The timing is such that the rotor rotates 120 degrees around the crank journal for each revolution of the shaft.

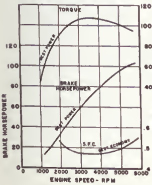
The center of gravity of the rotor is made coincident with the center of the crank journal, which makes it possible to balance all rotating forces. The shaft is balanced by two small counterweights, one on each end of the mainshaft. The complete balancing of the rotating masses permits a higher shaft RPM since there are no inertia forces to overcome.

These factors, together with the high RPM that the engine develops, yield a higher power-to-displacement ratio and therefore offer a smaller, lighter-weight engine.

Minimum volume occurs when the minor axis of the trochoid bisects the face of the rotor,

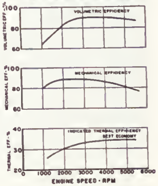
(Continued on page 22)

RCG TEST PERFORMANCE, FULL THROTTLE, SIDE INTAKE PORT



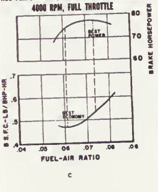
a

RCG TEST PERFORMANCE, FULL THROTTLE, SIDE INTAKE PORT



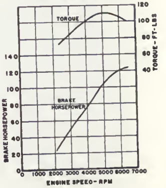
b

RCG PERFORMANCE, MIXTURE CHARACTERISTICS, 4000 RPM, FULL THROTTLE



c

RCG PERIPHERAL PORT



d

CAMPUS NEWS

THETA TAU

Still undefeated! The Theta Tau football team remained unbeaten by tying Delta Tau Phi and defeating Adams Hall.

Against a strong DT Phi team consisting of graduate law students, the TTau offense could not move. The only touchdown was scored by John Jenkins on a disputed kickoff return. One future lawyer, upset over the failure of an official to call a tag, demonstrated a remarkable vocabulary and thus was ejected from the action. The defense held the lawyers to one touchdown and the game ended in 6-6 tie.

In one of the most exciting games of the season the Red and Gold defense held for six plays on their own goal-line and saved a 12-6 victory over Adams Hall. A late Adam's drive put the ball on the one yard line. Four plays later, an interference penalty gave them another first down on the goal line but the Theta Tau defense held until the final whistle sounded. The touchdowns came for the good guys on a pass from Bruce Howard to John Jenkins, and on another kickoff return by speedy, tricky, agile, fakey John Jenkins.

In other athletic competition, Theta Tau had an exchange with Alpha Delta Pi. Led by fearless leader Marty Felker, and armed with beer, hot dogs, marshmallows, and a baby Fiat, the good guys more than held their own against the "tough" sorority girls and their leaders, Danny, Pat, Sue, Laura, and Stancy. The evening was livened up by the arrival of an ex-engineer from the University of Maryland who showed up in a park policeman costume. There are many who demand a rematch.

Congratulations to the pledges who will be initiated on Nov. 21 before the Banquet and Ball. They are (in alphabetical order):

Bruce Howard	Farid Shadid-Noorai
David Wong	Norman Hess
Doug Lowe	Robert Cohen
Ed Otto	

SIGMA TAU

Fall, 1964 Initiates:

Kenneth Belford	George Saxton
Thomas Dillon	Farid Shadid-Noorai
Albert Fratantuono	Morton Taragin
Francis LeBeau	Prof. Ojalvo, XI Chapter Faculty Advisor.
Steve MacIntyre	
Larry O'Callahan	

A banquet honoring the new members followed the initiation ceremony performed Saturday, Nov. 14.

Open Forums are conducted on the 3rd Wednesday of every month. Coming events in the Open Forum will feature representatives from the Athletic Dept., the Research Dept. and the Administration. All students and faculty are invited to attend any or all meetings. There is no official membership or dues. The sole purpose of the meetings can best be achieved through wide participation of the entire student body.

ASCE

Each year ASCE of Washington, D. C. gives a certificate and cash award to an outstanding civil engineering student from each of the area universities. Selection is by the faculty of the university and recognizes scholastic achievement, service to ASCE, and extra-curricula activities. This year's recipient from GWU is Ely Fishlowitz, president of our student chapter. The award was presented by faculty advisor Professor Raymond Fox at a dinner sponsored by the National Capital Section of ASCE held at the Cosmos Club on Nov. 10.

ASCE wishes to thank all those who helped work on the Homecoming Queen's Float. Although we were given the assignment of building the float, many non CE's added their efforts for which we are appreciative.

The next student chapter meeting will be a joint meeting with the mechanical engineers on Wed. Dec. 2 in TH 102 at 8:15 p.m. A guest speaker will talk on "Careers in Patent Law for Engineers". Everyone is urged to attend. Refreshments will be served.

Don't forget, election of new officers at the Jan. meeting.

ASME

The next meeting of ASME will be held on Wednesday, December 2, at 8:30 in the Dean's Conference Room, TH 106. For this meeting we have invited Mr. G. Franklin Rothwell, a senior partner of the patent law firm of Sughrue, Rothwell, Mion, Zinn, and MacPeak. Mr. Rothwell obtained a degree in Mechanical Engineering from the University of Missouri and a Juris Doctor degree G.W. Law School. Mr. Rothwell will speak on "Patent Law and the Engineer." ASCE will join with us for this meeting. There will be refreshments as always.

We would like to thank Bruce Howard for his fine selection of last month's ASME Mech Miss.

MECH MISS

Marge Ferm stonds 5'4" in her stocking feet, has brown hoir and big, brown Califarnia eyes. She enjoys SCUBA (that means Self Contoined Underwater Breothing Apparatus) diving and ploys volley ball and football.

Marge is o transfer student from the University of Hawaii where she learned to turn her inches (35-22-34) through the contorsions of hula doncing.

A senior, Marge is very octive oround campus. She is co-editor of the senior section of the Cherry Tree, was the Homecoming Decorations Chairman ond is the Booster Board secretory. Morge is sponsored by Sigmo Tou fraternity.

How to Build

A RESONANT FREQUENCY BATHROOM

by GUERDON TRUEBLOOD

In keeping with the "build-it-yourself" trend which is sweeping the country, the following article is presented in the hope that those hobbyists among the readers will find in it a new avenue on which to steer their creative efforts.

(Ed. note: This article is reprinted from the April 1955 issue of Mecheleciv. The editor feels it is too good to be kept from the public any longer.

Unfortunately, this article will only concern those people who like to sing in the bathroom. If you are not one of those select few who do, then I feel sorry for you; not because what I have to say will be of little interest to you, but rather that you have bypassed one of the finer things of life.

Any observant person has noted, as he sings away while bathing, that there is one note louder than the others, one note of brilliance and feeling. When you put your heart into that one frequency of sound, the whole house feels as if it were shaking with the beauty of it, and if your house is anything like the one I live in, it *is* shaking. Your imagination has nothing to do with it.

The reason for this occurrence is the simple law of resonance. As applied to this case, it may be stated that any reinforcement of sound caused by sympathetic vibrations is resonance. Only one frequency of sound, or a multiple of it, will cause the greatest reinforcement. The exact frequency depends on the volume of the room, or cavity, the gain in intensity of the sound depends on the rigidity of the walls. Other notes may seem louder in the bathroom, as compared with elsewhere, because it is a confined space and you are alone. But this is not resonance; it is art.

The first time I realized my bathroom was resonant, I felt weak inside, giddy, for with that realization had come a promise of an ecstatic future. You see, I was tired of solo work. It is adequate to a beginning bathroom artist, but it soon loses its glamour when you think of duets and accompaniment features. I tried the aria from "Faust" across the point of resonance and reeled drunkenly from the tub when I had finished the second ending. I have a high voice, unfortunately, but when I sang the high note of the aria, I heard another voice join mine to support the beauty of the thing: it was the voice of the bathroom. The sound of that one note set the bathroom to vibrating at its resonant point, one octave below my voice. It was breathtaking.

The tragic part of my discovery was learning that only one note could resonate the bathroom. Singing the same note can be pretty monotonous, if you have ever tried it. The only way to change the point of resonance was to change the volume of the bathroom cavity. I first tried placing large, airtight wooden boxes in the middle of the floor, and succeeded in raising the resonant point from D-flat to E-natural, a distance of three musical half-steps. I divided the total computed volume of all the boxes by three to determine the size of a box equivalent to one half-step, and then built three new boxes of just that volume each. I then had four different notes of resonance if I removed or added the new boxes to the bathroom cavity.

This system worked quite well until my wife put a stop to it. She said that she was sick and tired of hearing me stop in the middle of a song, splash out of the tub, open the bathroom door, throw one of the boxes into the hall, slam the door, jump into the tub and begin again on a different note. The wallpaper in the hall began to peel from the effects of the steam escaping through the door when I opened it. The door even suffered a mishap at the end of the second act of "The Pirates of Penzance." I was training myself to add or subtract a box from the room without losing a beat, and didn't quite get the door open when I threw one out. The bathroom got a new door and the boxes got the fireplace.

For weeks I wondered how to recapture the paradise I had known before, and yet have a greater range of resonance. Being an artist and not an athlete, I hoped to make the process automatic, or at least semi-automatic. One evening, I was sitting in the bathtub rendering my version of "The Desert Song," when my eyes strayed to the ceiling. The key was there; all I had to do was make the ceiling move up and down at my command. It would change the volume of the bathroom and thus its resonant

frequency, too. I would have the ultimate in artistic goals—the variable resonant frequency bathroom would be mine!

I computed the distance the ceiling would have to travel to change the frequency one half-step in pitch, picked an arbitrary point to be ceiling center pitch, and drew up the plans. The average hobbyist will have to consult a trained sound engineer for figures to suit his individual bathroom.

(A word of caution. Be discriminating in your choice of the man. Some people just wouldn't understand . . .)

The next step is procuring a 1908 OTIS two-story, steam operated, hydraulic elevator lift mechanism. I found it to be the most acceptable of all the commercial equipments available today. Recondition the machinery and then try a test run in your garage, using the family automobile for a suitable weight. Be careful to balance the car perfectly on the lift platform and refrain from raising it too high, or you may have to buy a new garage. I was fortunate in thinking to use my neighbor's garage and it became his problem when my Stutz went through the roof. You must forgive me, but most pioneers have been known to make mistakes. When it operates satisfactorily, go on to the next step.

The machinery must have a suitable platform to rest upon and in most cases the structure of the house has to be of steel reinforced. The machinery only weighs 4750 pounds, so your stress computations do not have to be too exacting. After the platform is constructed, an aperture must be opened in the roof to allow the crane to set the machinery in place. Bolt it down securely, with the lift platform just level with the ceiling at center pitch.

The boiler must then be installed in the basement. Any one will do, really. I used an 1867 Baldwin freight locomotive boiler which has rendered comparatively trouble-free operation since the time it indulged in a minor explosion which shattered all the windows in the house and flooded the basement. The simplest way to place it in the basement is to dig a sloping roadway in the lawn, down to the level of the basement floor. After removing a few bricks from the outside wall, the boiler slips into place easily. You may find it necessary to deepen your basement somewhat and strengthen the floor, but, again, this would be an individual problem for each house involved. The steam pipes to the lift mechanism should be run inside the house, as the loss in pressure from condensation during the winter months could raise havoc with the simplest chorale.

Next, you have to make a few simple alterations in the bathroom structure. Knock out the ceiling and insert a stainless steel sleeve flush with the walls and corners. Allow the bottom of the sleeve to sit three feet below ceiling center pitch and the top continue to at least three feet above center. Then construct a piston ceiling of one-half inch sheet steel to fit perfectly into the sleeve. When first inserted, mine squeaked as it slid up and down, but a few applications of Wildroot Cream Oil quieted it down considerably.

Then attach the steel ceiling to the lift mechanism by means of copper push rods. A few lever problems might arise, but a working knowledge of integral calculus should

First, a careful test run of the machinery should be made in your garage.

be more than adequate for their solution.

The majority of the work is now done. The bathtub control is the only remaining addition. An elevator handle is installed slightly above the soap dish in the spot where you always reach for the soap when your eyes are closed. This will enable you to always find the handle, and results in a considerable yearly savings on soap. The handle is connected to the lift mechanism and your variable resonant frequency bathroom is complete.

It might be suitable here to add a few safety features. A steam release valve on the boiler is a must. I learned this the hard way. A device to stop the ceiling after it comes down so far is a good idea, too. My sister's husband plays professional basketball, and one time when they were visiting, he mistook the ceiling control for the shower valve. He only received a minor concussion, but it could have ruined his career.

Some time will pass before you can judge just where to stop the ceiling to get the proper note, but it is worth all the practice you can afford. In the beginning, it may help to determine exactly where the tones are and mark the ceiling sleeve at those points. However, it is much better to learn to play the bathroom by ear; it is more natural. I can't possibly express how much enrichment my life has received, just from the outlay of a few dollars and the utilization of a few constructive weekends.

TAKE A LOOK AT TOMORROW!

FORD MOTOR COMPANY'S EXPERIMENTAL GAS TURBINE SUPERHIGHWAY TRUCK ANTICIPATES THE NATIONAL HIGHWAY NETWORK OF THE 1970's.

A new era in trucking is almost here. When the 41,000-mile national highway network is completed it will be possible for the first time to schedule coast to coast, big payload hauling. Ford Motor Company's answer to the challenge is this experimental tractor-trailer combination. A tandem axle drive tractor, powered by a 600 hp gas turbine engine permits a cruising speed of 70 miles per hour, a non-stop range of 600 miles. Designed for long-distance, non-stop operation, the two-man cab includes sleeping facilities, fold-away table, lavatory, toilet, oven, refrigerator and TV for the co-driver—with over 6'3" of headroom. Because of its cruising speed, the truck will be compatible with the normal passenger car flowrate of traffic. Other unique features are its odorless exhaust and extremely quiet operation.

Anticipating the opportunities and needs of the future is standard practice at Ford Motor Company. That's why it's such an exciting place to work. Look to Ford Motor Company for a career with growth potential and satisfaction—from pure science to manufacturing . . . marketing to labor relations.

THERE'S A FUTURE FOR YOU WITH . . . Ford MOTOR COMPANY

The American Road, Dearborn, Michigan

An equal opportunity employer

WHAT'S NEW

Edited by Martin Felker

WORLD ADOPTS NEW STANDARD OF TIME

An atomic definition of the second, the international unit of time, was authorized at 1725 Paris time, October 8, by the Twelfth General Conference of Weights and Measures, which was meeting in Paris that week. The international Committee on Weights and Measures, acting for the Conference, temporarily based the definition on an invariant transition of the cesium atom in expectation of a more exact definition in the future. The new definition replaces the definition of a second based on the annual orbit of the earth around the sun.

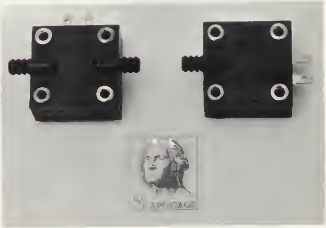
The action taken increases the accuracy of time measurements to a part in one hundred billion, an accuracy two hundred times greater than that formerly achieved by astronomical means. Moreover, these measurements can be accurately determined in a few minutes, as compared to the many years required to achieve an accuracy only one-hundredth as good by astronomical means.

LASER BLAST

A beam of light from this experimental ruby laser at the Westinghouse Research Laboratories gives off a shower of molten metal as it blasts its way through a piece of aluminum. The experiment demonstrates the tremendous concentration of light energy which can be obtained from a laser beam. Laser research under way at the Westinghouse Research Laboratories includes studies of the effects of laser beams, improved laser materials, energizing of lasers (pumping), use of the laser for microwelding and cutting, and basic research on the phenomenon itself.

PSF100 PRESSURE SENSOR

A new pressure sensor, which can function as a switch, fuse or detecting element, has been introduced by Fairchild Controls.



The PSF100 can sense level changes in liquids equivalent to less than 1/2" of water and can be utilized in detecting air-flows of the same magnitude. Yet, the pressure sensor is virtually insensitive to shock, vibration, acceleration or any other mechanical and physical environmental conditions.

Inventor of the PSF100, in a joint statement declared that some typical applications for the pressure sensor would include sensing of interruption or slowdown of airflow from small blower systems such as the type used to cool electronic equipment, detection of the presence of 1/2" of water or less in critical locations or sensing of changes in level of liquids in vats, storage tanks, etc. Other major applications for the device would be in the filling and bottling industries where exact levels have to be maintained in containers, or in the plastics molding industries to control the exact degree of pressures used to form the plastic containers.

Potential applications for the PSF100 can be found in processing industries including chemical, food, photographic, plastics, petroleum and data; medical, scientific and aerospace technologies; marine and automotive/aeromotive transportation areas; plus other industries such as mining, utilities, textiles, steel, and communications.

POLL PATTERNS SHOW SHARP CONTRASTS OVER FACULTY VIEWS TOWARD THE OPEN FORUM

by University Committee of Sigma Tau

As the polling of Faculty views toward the Open Forum entered its final stage, an analysis of the issues revealed sharp contrasts between different Professor's in the School of Engineering and Applied Science.

Here are some of the principal findings from a survey completed shortly before the 3rd Open Forum was conducted:

Remarks on Existing Open Forum

Two Faculty members favored the Open Forums but were reluctant to offer criticism in support of them. Two others were altogether unaware the forums were being conducted. One professor expressed a desire to have the Open Forum discussed at a Faculty meeting. A lone professor labeled the meetings "a bad idea", and yet another suggested they be replaced by luncheons. The issue of polling individual professors was split since one of the Faculty favored the action and one disapproved it. Only one Professor thought Wednesday night was a poor time to schedule the discussion group.

Remarks on Open Discussion

Individual Professors suggested the following topics for discussion at Open Forums: (1) the curricula, (2) the moral and social responsibilities of engineers, (3) the honor system (code of conduct), (4) the school spirit ("seems there is a lack of it"); (5) the question of whether or not the undergraduate school is going to be dropped, and (6) the long range objectives of our schools' goals.

Remarks on Forum Themes

Various Faculty members suggested that successful Forums could result from: a talk on "leadership" delivered by someone of prominence in the Psychology Dept., a NSF outlook on technical manpower, a speaker qualified to compare the merits of government employment versus a job in industry, a speech defining how the spending trend toward R&D will affect the future education of engineers, and, finally, an array of guest lecturers (from both within and without the University) treating the topics of: "creativity outside the University", "what industry expects from today's graduate engineer", or "what opportunities lie ahead for the engineer employed by NASA".

Further remarks from the Faculty fall in a general category, but nevertheless are comments of merit. Some suggestions were: (1) that Open Forum results be published, (2) that a student evaluation of the administration should be forthcoming, and (3) that contact with other departments of our school be made regarding Open Forums. Perhaps the most general statement received during the polling was from a Professor, new to our school, who gladly viewed the Open Forum as an opportunity to meet the students.

Since the Open Forum is indeed a place where Faculty and students meet, it subsequently provides the ideal opportunity for both factions to discuss subjects such as those arising out of the poll. Former President Woodrow Wilson recognized the importance of such meetings. He said: "Let us sit down and take counsel together, and, if we differ from one another, understand why it is that we differ from one another, just what the points at issue are. We will presently find that we are not so far apart after all, that the points on which we differ are few and the points on which we agree are many, and that if we only have the patience and the candor and the desire to get together, we will get together".

OPEN FORUM PROCEDURE

The open forums — as opposed to the panel discussion recently held — are intended to provide a means of communication or a vehicle by which individuals and/or groups may make their feelings known, find out answers to questions, constructively criticize complement, and in general discuss the future of G.W. In order to accomplish this, each and every person must realize that there is no such thing as a topic or speaker for the forum. Speakers will be asked to speak on subjects of general interest, but nevertheless, people other than the speaker should be asked a variety of questions. In other words, please change the subject and do not hesitate to address a question to anyone.

ROTATING COMBUSTION ENGINE (Cont'd.)

and maximum volume occurs when the rotor has rotated ninety degrees from this position. The difference of these volumes is defined as the displacement. This of course corresponds to the "top" and "bottom" positions of the piston in the cylinder.

Design Variations

The design of the basic engine can be altered to suit the power or operating characteristics desired. The variables affecting the operation of the engine are the K factor ($K = \frac{R}{e}$ the ratio of the radius of the trochoid to its eccentricity), the chamber width, the depth of the rotor pocket, the overall size, and the number of chambers in series. These factors are only mentioned here without discussion except to add that a diesel version requires a higher K factor to get a higher compression ratio, and that mounting chambers in series gives a better than linear increase in power.

Cooling

Cooling the rotating combustion engine is more difficult than in the ordinary reciprocating engine since the same surface is constantly in contact with the hot gases and is not cooled periodically as the cylinder is. This is shown qualitatively in figure 3. A liquid cooling system is employed which provides multiple flow passages parallel to the rotor axis. The system is designed to handle the uneven flow areas in regions of greater heat density. The rotor is internally oil-cooled as shown in the figure.

Sealing

As was noted earlier, sealing was one of the major problems to be overcome before a practical rotating combustion engine could be developed. Major developments have produced highly durable seals which have made possible an excess of 160 BMEP (brake mean effective pressure) in a single rotor 60 cubic inch engine.

Test Results

Tests on early engines using side intake ports yielded the results shown in figures 4a and 4b at full throttle. Later tests showed that for constant high speed operations (aircraft and marine) engines with intake ports located on the rotor housing periphery had volumetric efficiencies exceeding 100%. For low speed and low power operation, however, the side ported engine was more economical and yielded volumetric efficiencies of 90 - 95%.

Dr. Bentele (3) discusses the following tests.

Figure 4c demonstrates the power and fuel consumption as a function of the fuel/air ratio for full throttle constant speed. The values of 0.061 fuel/air ratio for best economy and 0.073 for best power show good combustion characteristics in the engine.

Figure 4d shows the performance of the same engine but equipped with a peripheral intake port. This port further reduced the intake losses resulting in correspondingly higher airflow and output. The engine delivered 124 hp (60 cu in displ) at 6500/RPM, equivalent to 2.05 hp per cu in, and again showed promise of further output increase with speed and some development.

The volumetric efficiency and airflow in figure 4e show the high-speed characteristic of this engine, with volumetric efficiencies exceeding 100% and a steadily increasing airflow with speed reaching almost 1100 lbs/hr at 6500 RPM.

Supercharging of the engine with carburetion produced the expected result in output growth with manifold pressure, namely, some 30% with 6" Hg boost pressure before the carburetor, see figure 4f. . . . . .

The high speed capability of this engine series was improved by optimization of the size, shape, and timing of the intake and exhaust ports, and was demonstrated in various test runs. A single rotor engine produced a maximum output of 143.8 BHP at 6500 RPM with a BSFC (brake specific fuel consumption) of .54 lb/hp/hr. This power is equivalent to 2.4 BHP/cu in displacement. The highest BMEP at 5000 RPM was 163 PSI.

Mixture control curves run at speeds from 5000 to 7000 RPM indicate good combustion characteristics although the fuel/air range for best power and best economy became somewhat narrower with increasing speed. Figure 6g depicts the results of such a test series, namely, the output and specific air and fuel consumption in relationship to the fuel/air ratio for various constant speeds. . . .

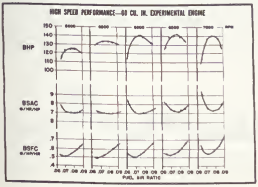
Similar optimization was applied to the medium and low speed range leading to improved performance over the initially reported data. A specific fuel consumption for best economy of .46 lb/hp/hr. was achieved.

OVERALL ADVANTAGES

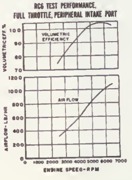
The overall advantages of the rotating internal combustion engine over the reciprocating and the gas turbine engines are that it has the light weight, small size, high speed and smooth operation of the gas turbine along with the lower cost of the reciprocating engine. It has fewer parts than the other two and requires far fewer tools for maintenance.

REFERENCES

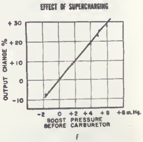
1. Australian Mechanical Engineering, Vol. 49, No. 4, November 6, 1961.
2. Popular Mechanics, Vol. 117, No. 6, June, 1962.
3. Curtiss-Wright's Experimental Rotating Combustion Engines, Dr. Max Bentele, Chief Scientist, Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, New Jersey.
4. Curtiss-Wright's Developments on Rotating Combustion Engines, M. Bentele, Curtiss-Wright Corp., Wood-Ridge, N. J., SAE Paper 288B, Jan. 9-13, 1961.



g



e



f

FIGURE 4—Continued

equipment will be restored to operational effectiveness within a given period of time in accordance with prescribed procedures." Maintainability is a function of maintenance action rate. There are two types of maintenance actions.

(1) Preventive maintenance action is carried out periodically according to specified procedure. This also includes replacing worn out parts.

(2) Corrective maintenance action is performed to restore an equipment to working condition when it fails.

Maintainability as defined above may be mathematically expressed as follows: $M = 1-e^{-\mu t}$ where μ = the maintenance action rate in maintenance actions per hour and ϕ = the mean maintenance time.

Some of the factors that improve maintainability are (1) The provision of fault location and isolation devices, which may consist of built in equipment or marginal test equipment. (2) Easy accessibility of parts. (3) Interchangeability and replaceability of parts. (4) Proper training of operating personnel. (5) Provision of standbys and redundancies.

Availability:

This is a function of the reliability and maintainability and may be defined as the probability that a stated per cent of equipment or missions will provide adequate performance in time T with no repair time exceeding t, the maintenance time constant. Poor reliability can be offset by improved maintainability. The faster the maintenance action rate the better the resulting availability.

Availability may be expressed by the following equation.

$$A = 1-e^{-\mu t}\ (1-3^{-rt})$$

The above equation indicates that the equipment availability at any time T is a function of r,μ and t, where r and μ have already been defined and t is the maintenance time constraint.

Conclusion:

Of the three terms discussed above, reliability is the most important one. It is becoming increasingly important and the United States Government in cooperation with various industries is doing extensive research in this field.

AUTOMATIC SORTING OF MAIL (Cont'd.)

character has been scanned, its characteristics are interpreted and a decision is made as to which letter (or letter grouping) has just been scanned. This fact, together with its position in the word is stored. Then after the entire word has been scanned, this stored data together with the number of characters in the word is interpreted to determine the word.

EXAMPLE: Suppose the stored data is:

1st character in word: Group 8
2nd character in word: Group 1
3rd character in word: Group 8
4th character in word: Group 2
ONLY 4 CHARACTERS IN THIS WORD.

This data would be interpreted as HAMP in New HAMP or N. HAMP. Then combining this word with a stored statement that the previous word was either N. or New would produce a statement that the two words just scanned spell an acceptable form of New Hampshire.

LOWER CASE Unlike recognizing upper case characters, as of this writing all attempts to recognize letters which are written in lower case have failed. These failures, or lack of ability to read characters written in lower case, touched off numerous independent investigations of lower case optical character recognition.

The most successful method of lower case optical character recognition presently known is to recognize certain special features together with their relative positioning. This method is predicated on being able to recognize the initial upper case character. That is to say, a word written in lower case may be recognized by the initial upper case character, the special features, the order of the special features, and the relative positioning or spacing of the special features.

There are three special features. The three vertical crossings found in a, e, s, and z are unique to these letters and may be reliably recognized notwithstanding broken, dirty, smudged, misplaced, etc. type. The second reliably recognizable special feature is a tall character. These are b, d, f, h, i, k, l. and t. The third special feature is a hangdown character. These consist of g, p, j, q, and y. The remaining letters, c, m, n, o, r, u, v, w, and x, are considered non-special feature characters and therefore can not be identified beyond the fact that a blob of ink is present. Thus, for example, if Maryland is being scanned the stored data in the lower case section would say in part:

1. Initial upper case character is M.
2. 1st special feature is 3X (3 crossing)
3. 2nd special feature is H (Hangdown)
4. 3rd special feature is T (Tall character)
5. 4th special feature is 3X
6. 5th special feature is T
7. There are only five special features.

If this is compared with, for example, Missouri, it is evident from the difference in the stored data that these two states may be reliably distinguished by this method of optical character recognition.

However, this method fails if, for example, Me (the official abbreviation of Maine) and Mex are to be distinguished. It is in words like these that the relative position of special features becomes important. Thinking of the end of the word as a fourth type of special feature, a piece of stored data which says there is one non-special character -- i.e., one blob of ink -- between the first and second special feature will distinguish Me from Mex and vice versa. Thus the number of non-special features separating special features helps to distinguish words written in lower case.

Further research revealed that this method is sufficient to reliably recognize and distinguish the cities and states in the U. S., and it is felt

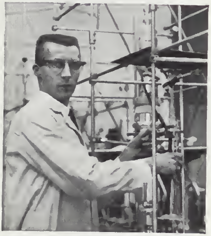
(Continued on page 27)

Men on the move at Bethlehem Steel

BRUCE SHAFEBOOK, MET.E., LEHIGH '60—Bruce supervises the metallurgical lab that watchdogs the quality of alloy, tool, and bearing steels made at our Bethlehem, Pa., Plant.

JACK LAMBERT, E.E., KENTUCKY '60—Jack works on design, installation, and maintenance of power stations, distribution networks, motors, and drive systems at our Steelton, Pa., Plant.

DON McCANN, M.E., PRATT '60—After experience as a maintenance, design, and construction engineer, Don became a cost-control specialist at our Lackawanna Plant, near Buffalo, N.Y.



BERNIE BAST, CH.E., PENN STATE '61—An engineer in our research laboratories in Bethlehem, Pa., Bernie is shown making distillation studies for a research project on coal chemicals.

ALVIN TYLER, MET.E., CASE INSTITUTE '60—"Tim" is a salesman assigned to our Buffalo District. His technical training is a valuable asset in selling steel products.

DON DIXON, C.E., MASSACHUSETTS '60—A field engineer in our Fabricated Steel Construction Division, Don supervises steel erection for major buildings and bridges.

These alert young men are a few of the many recent graduates who joined the Bethlehem Loop Course, one of industry's best-known management development programs. Want more information? We suggest you read our booklet, "Careers with Bethlehem Steel and the Loop Course." Pick up a copy at your Placement Office, or write to our Manager of Personnel, Bethlehem, Pa.

An equal opportunity employer

AUTOMATIC SORTING OF MAIL (Cont'd.)

that it will be sufficient to reliably recognize street names.

Therefore, to recognize a word written in lower case first the fact that it is written in lower case is sensed and the lower case circuitry is switched into the system. As the word passes the photoelectric device, each character is scanned. The initial upper case character is identified and stored. Each succeeding character is identified as either a tall character, a hangdown character, a three crossing character, or a non-special feature character. This information is stored in such a manner as to give the special features in order of occurrence, the total number of special features, and the number of non-special features between each pair of special features. At the end of the word this data is interpreted and a decision is made as to which word has just been scanned.

SUMMARY What has been discussed here is only the rudimentary principles upon which the machines presently being purchased by the Post Office are based. There are still many practical obstacles to overcome, and there are many recent advances in technology which can not be discussed here. But nevertheless, by employing the basic principles or methods discussed in this article, letters are automatically read and sorted at a rate of nearly a quarter of a million per hour, and at a mis-sort rate less than the human mis-sort rate.

INDEX TO ADVERTISERS

Inside front cover . . . . . . Westinghouse Electric Corp.

Page 1. . . . . Naval Ordnance Laboratory

Page 2 . . . . National Cash Register Co.

Page 5 . . . . American Oil Company

Page 6 . . . . Sikorsky Aircraft

Page 13 . . . . Western Electric Company

Page 20 . . . . Ford Motor Co.

Page 24 . . . . Melpar, Inc.

Page 26 . . . . Bethlehem Steel Company

Page 27 . . . . The Asphalt Institute

Page 28 . . . . Muth

Inside back cover . . . . . . Eastman Kodak Company

Back cover . . . . General Electric Company

THE SHAFT

She: "My dad is an Engineer. He takes things apart to see why they won't go."

He: "So what?"

She: "You'd better go."

* * *

Professor: "What are the bones in your hand called?"

Med. Student: "Dice."

* * *

Ah, pity The SHAFT editor,
The man with the scissors and paste;
Oh, think of the man who must read all the jokes
And think of the time that he wastes.
He sits at his desk until midnight,
How worried and pallid he looks,
As he scans through the college comics
And reads all the comical books.
This joke he can't clip--it's too dirty.
This story's no good--it's too clean.
This woman won't do--she's too shapely.
This chorus girl's out--it's obscene.
The jokes are the same; full of Coeds
And guys who get drunk on their dates,
Bathtubs and sewers and freshmen,
And stories of unlawful mates.
Jokes about profs and the readers,
Jokes about overdue bills,
Jokes about girls in their boudoirs,
And each one as old as the hills.
Sprinkled with "damn," "louse" and "hell,"
The blurbs must be pure but yet filthy
Oh pity the man with the clipper,
He's only a pawn and a tool.
In trying to keep his jokes dirty and clean
He's usually kicked out of school.

* * *

What did one typewriter say to the other?

"I must be pregnant because I just skipped a period."

Nowadays both a fool and his money usually end up in college.

* * *

In a recent survey, it was found that 9 out of 10 G.W.U. E.E. majors preferred high frequency to high fidelity.

* * *

Book Salesman: "Young man, you need this book. It will do half your college work for you."

M.E.: "Fine, give me two."

* * *

An attractive young coed was having difficulty keeping her skirt down about her shapely legs while awaiting a bus on a windy Washington street corner. She was aware of a young man watching her discomfort with considerable interest and she addressed him in an irritated voice:

"It is obvious, sir, that you are no gentleman."

With appreciation in his voice, the man replied, "It's obvious that you're not either."

* * *

There was a time when the music at the Engineer's Ball was so bad that when a waiter dropped a tray, everybody got up and started dancing.

* * *

Girls get minks the same way minks get minks.

* * *

Women are the problem that most men like to wrestle with.

* * *

E.E.: The driver of that car ahead must be my physics prof.

M.E.: Why?

E.E.: Because he's so stubborn about letting me pass.

* * *

"Your husband looks like a brilliant man. I suppose he knows everything."

"Don't be silly. He doesn't suspect a thing."

* * *

Professor: "You missed my class yesterday, didn't you?"

Student: "Oh, no sir, not in the least."

M.E. Prof.: "If you were at the top of a tall building, how could you measure the height, using a barometer?"

Student: "I would tie a rope on the barometer, lower it to the ground, and then measure the rope."

Another Student: "I would drop the barometer off of the top of the building, measure the time it took to fall, and compute the height of the building from $S=1/2gt^2$."

Third Student: "Well, I would stand the barometer up, measure the length of its shadow, ask someone on the ground to measure the length of the building's shadow, and compute the height of the building by ratios.

* * *

Overheard at the cafeteria:

First cook: "Hey, the garbage man is outside."

Dietician: "OK, tell him to leave three cans today."

* * *

Coed: "If wishes came true, what would you wish for?"

Engineer: Gosh, I'm afraid to tell you."

Coed: "Go ahead, you sap. What do you think I brought up this wishing business for?"

* * *

Captain: "Why didn't you salute me yesterday?"

ROTC Recruit: "I didn't see you, sir."

Captain: "Oh, all right then. I was afraid you were mad at me."